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The MONTHLY REVIEW

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IN THIS ISSUE

Editorial — Getting Ready for the Convention 5

Hirsch — Efficiency of a Horizontal Plating Barrel 7

Anderson — The Relation of Coating Thickness to Outdoor Service Life on Zinc Alloy Die Castings 11

1935 Convention of the A. E. S. 21

Principles of Chemistry — Lesson II .. 24

Meyer and Helmle — The Structure of Polished Metal Surfaces .. 29

Publications on Electrodeposition from the National Bureau of Standards 41

The Abstract Section 49

Branch News 55

Membership Report 61

Membership Drive Barometer 63

Branch Directory 64

Buyers' Guide 65

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The MONTHLY REVIEW

Published by the
AMERICAN ELECTRO-PLATERS' SOCIETY

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VOL. XXII FEBRUARY 1935 NO. 2

Getting Ready for The Convention

[*Editorial*]

MR. Eugene Phillips, Publicity Committee Chairman of the National Convention, reports as follows:

The appointment of the various committees has been completed and all of them have started activities. Considerable interest has been displayed by members, and all of our meetings have been well attended.

We are advised by the Chairman of the paper committee that he has been able to secure several outstanding technical papers which we are sure will be highly interesting and educational to the craft.

The Chairman of the program committee reports that he has mailed letters to potential advertisers and the results thus far have been very gratifying.

The General Chairman reports that very fine progress has been made to date. There is much enthusiasm concerning the probability of this convention being one of the most successful affairs we have ever held. Interesting plant visitations are being arranged and many interesting trips and social functions are being prepared for the ladies.

The Editor was requested to attend one of the recent meetings called by General Chairman R. J. O'Connor in New Haven, Conn. At this meeting nearly all the Committee Chairmen were present giving reports of the progress made so far.

There was a fine feeling of harmony and optimism all through the session and all felt that the preparations now being made

will make the Bridgeport Convention so attractive that no plater or factory executive can afford to miss it.

The educational value is being stressed as never before. Papers by practical platers and technical men are being arranged so that these sessions alone will be most interesting and instructive.

Mr. R. T. Phipps, Exhibits Chairman, is an enthusiastic worker and is well pleased with the support given to this part of the Convention program. Many letters are being received desiring information and the sale of space is far exceeding expectations.

The social events planned for this year's convention will more than equal anything ever held before. Each place one visits in New England has something of interest and historic value, to say nothing of the beauty with which nature has so lavishly endowed this section of the country, especially in the "good old summertime" when the meetings are scheduled to be held.

The Ladies' Committees were in session on the same evening and there was no secret about their determination to make visitors and delegates feel so much at home that a platers' convention in one of the New England cities will be demanded every two or three years.

We predict that this year's meeting will be the best ever held. Business of the utmost importance to the future of our organization will be transacted. Plan your vacation now. Represent your Branch as a delegate. We want every Branch from Boston to California represented this year. No proxies—if possible.

The following well known firms have taken space for exhibition purposes at the Bridgeport Convention:

	Booths		*Booths*
The Udylite Co.	3	Egyptian Lacquer Co.	1
Contract Plating Co.	1	Norton Co.	1
Hanson-Van Winkle-Munning Co.	2	Maas & Waldstein Co.	1
Lea Mfg. Co.	1	Zapon Co.	1

Many other concerns are making inquiries regarding space. Information concerning exhibits can be had by communicating with R. T. Phipps, The Bullard Co., Bridgeport, Conn.

Efficiency *of a Horizontal Plating Barrel*

By ALBERT HIRSCH
Member of Philadelphia Branch

Read at Philadelphia Branch
December 21, 1934

THE effective current density in the barrel, the thickness of the deposit obtained, and the efficiency of the horizontal immersed-type plating barrel used, have been studied. A method of calculating the current efficiency is suggested and explained. The plating barrels used in the present study were found to be approximately 19.4% efficient.

INTRODUCTION

Plating to meet specifications, such as minimum thickness of deposit, and number of hours treatment in a salt-spray without breakdown, is becoming more frequently demanded, largely by the automotive industry. For this reason the present study of the quality and quantity of plate deposited, using a plating barrel, was undertaken.

In order to give the results their full significance, a brief description of the barrels used, and the plating conditions under which these experiments were carried out, is given. A horizontal plating barrel, of the button, single live end, immersed type were used, the current being furnished by a 6-12 volt, 1000-2000 ampere generator set. Oblique tumbling barrels were used for the cleaning. The pressed steel parts were taken from the press, together with the oil and drawing compound, and "Dry Ground" (see Hirsch, trans. Electrochem. Soc. 63, p. 135, (1933)) in a horizontal tumbler with maplewood sawdust and No. ff powdered pumice stone for two hours. This treatment removes all burrs and grease, leaving the steel with a finish resembling a sand-

blast finish. After the grinding operation, the steel pieces were placed in an oblique tumbler and cleaned with sal soda. Finally, the parts were barrel-plated with copper (using a cyanide copper solution) for two hours, then barrel-plated with nickel for four hours, and finally ball-burnished. This represents the standard treatment such parts receive during daily production.

DETERMINATION OF THICKNESS OF DEPOSIT

Since it is difficult to measure accurately the area of irregularly-shaped stampings, small, fairly heavy pieces of cold-rolled steel, of dimensions about 5 x 5 cms. (2 x 2 in.) giving a total area of 50 sq. cm. or 0.5 sq. dm. (8 sq. in.) since both sides receive a deposit, were plated along with a normal load of work having a surface area of approximately 465 sq. dm. (50 sq. ft.) Thin pieces of steel are unfit for the experiment as they bend too easily. The load was plated for two hours in a cyanide copper solution with a total current of 300 amperes, at 12 volts pressure and at a temperature of 170° F. After plating the test pieces of steel were weighed, stripped of the deposit in fuming nitric acid, and reweighed. The stripping solution was then analyzed gravimetrically for iron, and volumetrically for copper. The weight lost by the iron test pieces in the stripping solution is equal to the weight of the copper deposit plus the weight of whatever iron from the plated strip dissolved in the nitric acid. Therefore, the difference between the loss in weight of the steel test pieces and the weight of the iron in the stripping solution (as found by analysis) equals the total weight of the copper deposit. The total weight of copper thus obtained agreed well with that obtained by the direct analysis of the stripping solution.

The total weight of the copper deposit, divided by the electrochemical equivalent of copper in grams per ampere hour, (for a cyanide bath) i.e. 2.372 (Blum and Hogaboom, "Principles of Electroplating and Electroforming", McGraw-Hill, 2nd Ed. 1929, p.406), gives the total ampere-hours employed in actual copper deposition. These effective ampere-hours, divided by the recorded plating time, gives the effective current for copper deposition per total surface of the load. From these figures the effective current density in the barrel can be calculated, as well as the thickness of the deposit and the efficiency of the plating barrel.

CALCULATION OF PLATING BARREL EFFICIENCY:-

The effective ampere-hours per total surface of the load, divided by the recorded ampere-hours used during the plating of the load, gives the efficiency of the barrel. Therefore:—

$$\text{Efficiency of the plating barrel, in percent} = \frac{\text{effective ampere-hours} \times 100}{\text{Recorded ampere-hours}}$$

The total weight of copper deposited on the 0.5 sq. dm. area of the test pieces was found to be 0.297 g.

Total area of load plated = 465 sq. dm.

Therefore, total weight of copper deposited on the entire load

$$= \frac{0.297 \times 465 \text{ g.}}{0.5}$$

Now 1 ampere-hour will deposit 2.372 g. of copper so that the number of ampere-hours required to deposit the above weight of copper (i.e. the effective ampere-hours) will be

$$= \frac{0.297 \times 465}{0.5 \times 2.372} \text{ ampere-hours}$$

$$= 116.4 \text{ ampere-hours}$$

The current used on the barrel was 300 amperes, and the plating time was two hours, so that the recorded number of ampere-hours was 300 x 2, or 600 ampere-hours.

Therefore:—

$$\text{Efficiency of Barrel in percentage} = \frac{\text{Effective ampere-hours} \times 100}{\text{Recorded ampere-hours}}$$

$$= \frac{116.4 \times 100}{600}$$

$$= 19.4\%$$

Thus it will be seen that in barrel plating, some 80% of the current applied is wasted, since only 20% is used for actual metal deposition.

CALCULATION OF EFFECTIVE CURRENT DENSITY:-

From the above, the effective ampere-hours = 116.4.

Since the current was passed for two hours, the effective current on the work must have been $\frac{116.4}{2}$, that is 58.2 amperes.

This effective current is for an area of 465 sq. dm.

Therefore:—

Current Density in amperes/sq.dm. $= \frac{58.2}{465}$

$= 0.125$ amp/sq.dm.

(or 1.16 amp./sq.ft.)

CALCULATION OF THICKNESS OF DEPOSIT:-

From the fact that:—

8.9 g/sq.dm. of copper gives a deposit of 0.01 cm. thick (Blum and Hogaboom, ibid) it can be seen that

8.9 x 100 x 2.54 g. copper/sq.dm. give a deposit of 2.54 cm. (or 1 inch) in thickness so that

$\frac{8.9 \times 100 \times 2.54 \text{ g. copper/sq.dm.}}{1000}$ give a deposit of 0.001 inches (one-one thousandth of an inch) in thickness.

=2.26 g. copper/sq.dm. for a copper deposit 0.001 inches thick.

Now, in the above plating 0.297 g. of copper were deposited on 0.5 sq. dm. of surface, equal to 0.594 g./sq.dm. of surface.

Thus, since 2.26 g copper per sq. dm. represents a deposit of 0.001 in. thick, the thickness of the above deposit must be

$\frac{0.594}{3.26}$ thousandths of an inch

$= 0.264$ thousandths

(i.e.; 0.000264 inches or slightly more than 2½ ten thousandths inches.)

Note:—The efficiency of nickel plating-barrel was similarly determined and found to be 38.5% efficient.

The author's thanks are gratefully given to Dr. Edward B. Sanigar who not only checked the arithmetical results but also suggested their presentation in the form given.

The Outstanding Contract

To back up its contention "that it was heartily in favor of a *real* exhibition and convention," Mr. Berry of the Udylite Co. of Detroit, Mich., telephoned from that city reserving three booths at the A. E. S. Bridgeport Convention and Exposition, stating that the contract and check would be mailed that same day.

The Udylite Co. states: "it will do its utmost to put on one of the finest exhibits they have ever displayed before the public."

The Relation of Coating Thickness to **Outdoor Service Life** *on Zinc Alloy Die Castings*

By E. A. ANDERSON

Read at Detroit 1934 Convention

IT has been said that the best defense is a strong offense. The plating industry today is definitely in need of a strong defense against the intrusion into its field of organic finishes and of metals which need no plating. No stronger defense can be imagined than the economical production of truly satisfactory plated finishes.

It is easy enough to make the statement that low cost durable deposits should be the rule rather than the exception, but it is surprisingly difficult to answer the obvious question, "What constitutes a satisfactory coating?"

The word surprisingly is used advisedly, because through all of the long history of plating in the United States attempts to correlate plating procedure and thickness of coating with service life have been conspicuous by their absence until recent years.

It is the writer's belief that one of the major causes for this situation has been the continued dependence on accelerated tests for information regarding the durability of plated coatings. Regardless, however, of the cause, the fact remains that a pressing need exists today for information regarding the requirements in plating methods for acceptable outdoor service life.

The continuous outdoor exposure tests now being carried out by this Society in cooperation with the Bureau of Standards and the American Society for Testing Materials fill to a considerable extent this need. It is hoped that the support necessary for the continuation and extension of this work will be forthcoming.

In the work reported here we have attacked the problem of correlating coating life with the thickness of the coating and the method of application from a somewhat different viewpoint. While a great deal of vital information can be obtained from continuous outdoor exposure tests, there is need in addition for direct service tests capable of giving an authentic answer to the question of what coating actually is needed for a given condition of service.

To obtain this information for one condition of service, plated specimens were attached to racks on the sides of a light truck operated during the daylight hours in inter-plant service at Palmerton, Pennsylvania. This method of exposure duplicated actual service condition in every essential excepting the variable of handling.

The exposure period covered by the data reported here includes one year of service.

I. PREPARATION OF SPECIMENS

CASTINGS USED

All of the tests included in this work were made on one die cast shape cast under commercial conditions in the A. S. T. M. No. XXI Alloy (S. A. E. No. 921.)

PREPARATION FOR PLATING

The operation of removing the parting lines by polishing had been carried out before the castings were shipped to us. It was only necessary to buff the parts with tripoli prior to cleaning and plating. The buffing procedure used was comparable with commercial practice on similar castings with the possible exception of the pressure exerted by the operator in applying the work to the wheel. It is probable that in commercial production buffing, somewhat higher pressures are employed.

After buffing, the castings were cleaned cathodically for one minute in a hot solution of trisodium phosphate in water (6 ounces per gallon) followed by thorough rinsing. After the last rinse the parts were dipped for a few seconds in a cold 10 per cent solution of hydrochloric acid. After a final rinse they were ready for plating.

PLATING SOLUTIONS USED

The deposits tested were produced in several types of solution as follows:

Solution I

Nickel Sulphate	7.5	oz. per gallon
Nickel Content	1.5	oz. per gallon
Sodium Sulphate*	11.25	oz. per gallon
Ammonium Chloride	3.0	oz. per gallon
Boric Acid	2.0	oz. per gallon
*Anhydrous		
pH — Quinhydrone	5.2	
Temperature	74°F	
Current Density	12	amperes per sq. ft.
Agitation		moving cathode rod

Solution II

Nickel Sulphate	10	oz. per gallon
Nickel Content	2	oz. per gallon
Sodium Sulphate*	15	oz. per gallon
Ammonium Chloride	2	oz. per gallon
Boric Acid	2	oz. per gallon
*Anhydrous		
pH — Quinhydrone	5.3	
Temperature	74°F	
Current Density	15 and 24	amperes per sq. ft.
Agitation		moving cathode rod

Solution III

Nickel Sulphate	15	oz. per gallon
Nickel Content	3	oz. per gallon
Sodium Sulphate*	15	oz. per gallon
Ammonium Chloride	3	oz. per gallon
Boric Acid	2	oz. per gallon
*Anhydrous		
pH — Quinhydrone	5.3	
Temperature	86°F	
Current Density	30	amperes per sq. ft.
Agitation		moving cathode rod

Solution IV

Nickel Sulphate	20	oz. per gallon
Ammonium Chloride	4	oz. per gallon
Boric Acid	2	oz. per gallon
pH — Quinhydrone	5.0	
Temperature	105°F	
Current Density	50	amperes per sq. ft.
Agitation		moving cathode rod

Solution V

Sodium Cyanide	6	oz. per gallon
Cuprous Cyanide	4	oz. per gallon
Sodium Bicarbonate	1	oz. per gallon
Sodium Bisulphite	¼	oz. per gallon
Temperature	74°F	
Current Density	15	amperes per sq. ft.

Solution VI

Copper Sulphate	24	oz. per gallon
Sulphuric Acid	8	oz. per gallon
Temperature	95°F	
Current Density	30	amperes per sq. ft.

Solution VII

Nickel Sulphate	16	oz. per gallon
Ammonium Chloride	2	oz. per gallon
Boric Acid	2	oz. per gallon
pH — Quinhydrone	2.0	
Temperature	115°F	
Current Density	40	amperes per sq. ft.
Agitation		moving cathode rod

Solution VIII

Chromic Acid	33	oz. per gallon
Sulphuric Acid	0.3	oz. per gallon
Temperature	74°F	
Current Density	125	amperes per sq. ft.

Some of the specimens included in the exposure tests were plated in a commercial plant. The solution compositions were reported as follows:

Solution IX

Nickel Sulphate	10	oz. per gallon
Sodium Sulphate*	30	oz. per gallon
Ammonium Chloride	2.5	oz. per gallon
Boric Acid	4	oz. per gallon
*Anhydrous		
pH — Quinhydrone	3.5	
Temperature	74°F	
Current Density	20	amperes per sq. ft.
Agitation		moving cathode rod

Solution X

Same as Solution IX but operated at pH—Quinhydrone of 5.3.

Solution XI

Same as Solution X but used as strike solution at 55 amperes per square foot.

Solution XII

Same as Solution IX but operated as follows:

pH — Quinhydrone	4.5	
Temperature	105°F	
Current Density	25	amperes per sq. ft.
Agitation		continuous automatic tank

PLATING OF SPECIMENS

Nine coatings were plated under each of the following conditions:

No.	Solution	Current Density per Sq. Ft.	Weight of Coating Grams per Sq. Ft.		Plating time — Minutes	
H-1883	I	12	3		15	
H-1884	I	12	6		28	
H-1885	I	12	11		48	
H-1886	I	12	22		95	
H-1887	II	15	3		12	
H-1888	II	15	6		25	
H-1889	II	15	11		44	
H-1890	II	15	22		90	
H-1891	II	24	3		8	
H-1892	II	24	6		16	
H-1893	II	24	11		28	
H-1894	II	24	22		58	
H-1895	III	30	3		7	
H-1896	III	30	6		13	
H-1897	III	30	11		22	
H-1898	III	30	22		45	
H-1899*	II	18	strike	22	5	27
	IV	50	22		22	
H-1900*	II	18	strike	22	5	38
	IV	50	33		33	
H-1901**	V	15	strike		5	41
	VI	30			19	
	VII	40	11		17	
H-1902**	V	15	strike		5	36
	VI	30		22	19	
	VII	50	11		12	
H-1903**	II	24	4.4		13	40.5
	VI	30	8.8	22	18	
	IV	50	8.8		9.5	
H-1904	VIII	125	3		16	
H-1905	VIII	125	6		33	
H-1906	VIII	125	9		44	
C-2653	IX	20	3		No data	
C-2654	IX	20	6		No data	
C-2655	IX	20	11		No data	
C-2656	IX	20	22		No data	

*Specimens rinsed between plating operations

**No buffing on primary coats

Solution VI

Copper Sulphate	24	oz. per gallon
Sulphuric Acid	8	oz. per gallon
Temperature	95°F	
Current Density	30	amperes per sq. ft.

Solution VII

Nickel Sulphate	16	oz. per gallon
Ammonium Chloride	2	oz. per gallon
Boric Acid	2	oz. per gallon
pH — Quinhydrone	2.0	
Temperature	115°F	
Current Density	40	amperes per sq. ft.
Agitation		moving cathode rod

Solution VIII

Chromic Acid	33	oz. per gallon
Sulphuric Acid	0.3	oz. per gallon
Temperature	74°F	
Current Density	125	amperes per sq. ft.

Some of the specimens included in the exposure tests were plated in a commercial plant. The solution compositions were reported as follows:

Solution IX

Nickel Sulphate	10	oz. per gallon
Sodium Sulphate*	30	oz. per gallon
Ammonium Chloride	2.5	oz. per gallon
Boric Acid	4	oz. per gallon
*Anhydrous		
pH — Quinhydrone	3.5	
Temperature	74°F	
Current Density	20	amperes per sq. ft.
Agitation		moving cathode rod

Solution X

Same as Solution IX but operated at pH—Quinhydrone of 5.3.

Solution XI

Same as Solution X but used as strike solution at 55 amperes per square foot.

Solution XII

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No.	Solution	Current Density per Sq. Ft.	Weight of Coating Grams per Sq. Ft.		Plating time — Minutes	
H-1883	I	12	3		15	
H-1884	I	12	6		28	
H-1885	I	12	11		48	
H-1886	I	12	22		95	
H-1887	II	15	3		12	
H-1888	II	15	6		25	
H-1889	II	15	11		44	
H-1890	II	15	22		90	
H-1891	II	24	3		8	
H-1892	II	24	6		16	
H-1893	II	24	11		28	
H-1894	II	24	22		58	
H-1895	III	30	3		7	
H-1896	III	30	6		13	
H-1897	III	30	11		22	
H-1898	III	30	22		45	
H-1899*	II	18	strike	22	5	27
	IV	50	22		22	
H-1900*	II	18	strike	22	5	38
	IV	50	33		33	
H-1901**	V	15	strike		5	41
	VI	30			19	
	VII	40	11		17	
H-1902**	V	15	strike	22	5	36
	VI	30			19	
	VII	50	11		12	
H-1903**	II	24	4.4	22	13	40.5
	VI	30	8.8		18	
	IV	50	8.8		9.5	
H-1904	VIII	125	3		16	
H-1905	VIII	125	6		33	
H-1906	VIII	125	9		44	
C-2653	IX	20	3		No data	
C-2654	IX	20	6		No data	
C-2655	IX	20	11		No data	
C-2656	IX	20	22		No data	

*Specimens rinsed between plating operations

**No buffing on primary coats

No.	Solution	Current Density Amperes per Sq. Ft.	Weight of Coating Grams per Sq. Ft.	Plating time — Minutes
C-2657	X	20	3	No data
C-2658	X	20	6	No data
C-2659	X	20	11	No data
C-2660	X	20	22	No data
C-2661	X	55	strike } 3	1
	XII	25	}	No data
C-2662	X	55	strike } 6	1
	XII	25	}	No data
C-2663	X	55	strike } 11	1
	XII	25	}	No data
C-2664	X	55	strike } 22	1
	XII	25	}	No data

**No buffing on primary coats

VERIFICATION OF WEIGHT OF COATING

The original plan called for exposure of four check specimens on each of two exposure racks. The ninth specimen was available for determination of weight of coating. Data on this point were obtained from the change in weight of the castings during plating and from measurements on the microscope at two points on the casting. The data are too bulky for inclusion here, and it should suffice to state that the intended thicknesses were obtained within the following limits of tolerance:

Grams per Sq. Ft.	Intended Wt. of Coating — Inch	Intended Wt. of Coating per handle — grams	Tolerance per Handle — Grams
3	0.00015	0.3122	±0.045
6	0.0003	0.6244	±0.09
11	0.0005	1.146	±0.165
22	0.001	2.290	±0.33
33	0.0015	3.435	±0.50

All of the nickel plated specimens were colored after the final nickel plating operation, and were further plated with 0.00002 inch deposit of chromium.

II. EXPOSURE CONDITIONS

The completed specimens were mounted in sets of four duplicates of each thickness of coating and type of solution on board panels fastened to the sides of a small truck.

The position of the handles relative to the board mountings was made as nearly identical as possible with the position of the part in use. A light cover of safety screening was installed to protect the specimens from theft or casual damage.

The truck is used in inter-plant service at Palmerton, Pennsylvania. During the year covered by the present tests the truck was operated a distance of 15,801 miles. The car is used 8½ hours a day for six days a week during daylight hours and is stored in a heated commercial garage at night.

Palmerton is situated in Eastern Pennsylvania in a restricted valley. Typical meteorological data for the year June 1, 1933 to June 1, 1934:

Average Temperature — °F.	49
Minimum Temperature — °F	-15
Maximum Temperature — °F	97
Average Humidity — per cent	73
Total Rainfall — inches	42.04

In addition to these data, it may be mentioned that early morning fogs in the valley are frequent. A high ridge on the south side of the town prevents access of the sun until 8:30 or 9:00 A.M., thus permitting these fogs to persist until the truck has been in service for an hour or so.

A second set of racks was installed on a small truck operated in Northern Michigan. The specimens were seriously damaged in an accident, however, and the test was abandoned.

III. INSPECTION DATA

While the specimens were wiped off with a wet cloth and examined once a month, only the last or one year inspection will be considered here. In making this latter inspection the specimens were removed from the racks and brought to the laboratory, where a careful examination was made with the aid of a binocular microscope. This procedure was necessitated by the fact that corrosion had in no case advanced to the point where positive identification of corrosion blisters could be made with the unaided eye.

The results of the one year inspection are tabulated on the following page.

Number	Thickness Inches	Type of Coating	Inspection Blisters	Inspection Cracks	Blisters in Cracks
H-1883	0.00015	Nickel	Few	None	None
H-1884	0.0003	Nickel	None	Yes	None
H-1885	0.0005	Nickel	None	Yes	None
H-1886	0.001	Nickel	None	Yes	None
H-1887	0.00015	Nickel	Few	Yes	None
H-1888	0.0003	Nickel	Very few	Yes	None
H-1889	0.0005	Nickel	None	Badly	*
H-1890	0.001	Nickel	None	Badly	*
H-1891	0.00015	Nickel	Few	Yes	None
H-1892	0.0003	Nickel	None	Yes	*
H-1893	0.0005	Nickel	None	Badly	*
H-1894	0.001	Nickel	None	Badly	*
H-1895	0.00015	Nickel	Few	None	None
H-1896	0.0003	Nickel	None	None	None
H-1897	0.0005	Nickel	None	Yes	None
H-1898	0.001	Nickel	None	Yes	None
H-1899	0.001	Nickel	None	None	None
H-1900	0.0015	Nickel	None	None	None
H-1901	0.001	Copper-Nickel	None	None	None**
H-1902	0.001	Copper-Nickel	None	Very slight	None**
H-1903	0.001	Nickel-Copper-Nickel	None	None	None
H-1904	0.00015	Chromium-direct	?	None	None
H-1905	0.0003	Chromium-direct	None	Yes	None
H-1906	0.00045	Chromium-direct	None	Yes	None
1b	0.00015	Nickel	Many	None	None
2b	0.0003	Nickel	Yes	Yes	None
3b	0.0005	Nickel	Yes	Badly	None
4b	0.001	Nickel	None	Badly	*
1a	0.00015	Nickel	Many	Yes	Yes
2a	0.0003	Nickel	Many	Badly	Yes
3a	0.0005	Nickel	Yes	Badly	Yes
4a	0.001	Nickel	None	Badly	Yes
1c	0.00015	Nickel	Many	None	None
2c	0.0003	Nickel	Few	None	None
3c	0.0005	Nickel	Few	None	None
4c	0.001	Nickel	None	None	None

*Lifting of edges of cracks suggests penetration of corrosion along cracks.

**Copper stains.

Before discussing the inspection data it may be well to point out that after one year of exposure under the conditions defined above, none of the specimens showed sufficient corrosion to make them unsightly. At a normal observation distance of two or three feet the specimens all appeared to be in perfect condition.

Examination of the detailed inspection data reveals several interesting results. Regardless of plating method used all coatings of the 3-gram per square foot thickness (0.00015″) have started to develop corrosion blisters. In the normal course of events it should not require many weeks of additional exposure before obvious unsightly failure has developed.

Of the heavier coatings only those plated for us show appreciable signs of corrosion. While a natural conclusion, based on the data supplied to us with the specimens, would be that the high sodium sulphate content of the solution was deleterious to corrosion resistance, the writer would prefer to leave this conclusion open, since it is conceivable that other unexpected variables in buffing and cleaning may have developed during the plating procedure.

In addition to the normal failure by the production of blisters, a second type of defect has become apparent, especially in the heavier coatings. It will be noted in the table that certain of the heavier coatings have developed cracks. In examining these particular coatings on the microscope, distinct evidence can be seen in certain specimens of corrosion developing in the cracks. If this condition persists a relatively early failure of the particular specimens involved can be anticipated.

It would seem, from the results obtained, that while these exposure tests will require considerable additional time to reach a state where complete positive conclusions can be drawn, two conclusions may be developed at the present time: (1) that coatings in the region 0.00015″ in thickness are inferior in corrosion resistance to coatings 0.0003″ and heavier, and (2) that care must be taken in applying the heavier coatings to avoid cracking. Needless to say, the exposures discussed in this paper are being continued, and the results will be reported from time to time as new conclusions become apparent.

It was not found possible in a series of tests as extensive as the present to develop a method of handling the specimens to

introduce the factor of perspiration into the exposure cycle. The writer has no data on which to base a conclusion as to whether or not perspiration has any influence on the life of a given plated coating.

Throughout this paper no attempt has been made to draw conclusions for any exposure condition other than that involved in the current tests. It is felt, however, that the information given here is of value in selecting from the methods of preparation and the thickness of coating those conditions which are obviously unsuited to even a moderate condition of exposure. Application of the results to more severe corrosive conditions will have to be made on the basis either of additional tests or of experience in the variety of locations on the part of the persons wishing to use the information. (Applause)

CHAIRMAN SLATTERY: Mr. Anderson will be pleased to answer any questions on this paper.

DR. BLUM: The first question that I want to ask, before commenting, is as to whether, in these tests on the truck, the truck was indoors at night, or was outside during the twenty-four hours?

MR. ANDERSON: I should have mentioned that in presenting the data. The truck was housed in a commercial heated garage at night.

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1935 **Convention** *of the American Electro-Platers' Society*

June 10-11-12-13
Bridgeport, Conn.

THOSE who plan to attend the 1935 Convention and Exhibition of the American Electro-Platers' Society to be held in Bridgeport, Connecticut, June 10-11-12-13, will surely carry back home with them pleasing memories of their visit to the "Industrial Capital of Connecticut."

Bridgeport possesses many attractions that few cities—industrial or otherwise—can equal or surpass. An industrial city, yes, but with a beautiful location on Long Island Sound, beautiful parks, beautiful homes, unexcelled bathing beaches, good hotels, up-to-date theatres, fine restaurant and meeting facilities, charming suburbs, careful and courteous traffic regulations.

Bridgeport early became important as a trading center because of its excellent harbor and owing to its location in what was then a rich farming region. When the industrial era arrived, these same advantages—combined with its nearness to the New York market—encouraged the manufacturers of a century ago to locate here. Needless to say, Bridgeport's tremendous industrial development is its chief characteristic today and has earned the city its soubriquet of "The Industrial Capital of Connecticut."

Bridgeport, first known as "Pequonnock," received its first white settlers in 1639. In 1701 the name was changed to Stratfield—a combination of Stratford on the east and Fairfield on the west—and in 1836 Bridgeport was incorporated as a city.

Not only is Bridgeport's water-borne commerce large and important, but the city's location on Long Island Sound furnishes one of its greatest natural attractions. Long Island Sound is 14 miles wide at this point and the expanse of blue sea lying at Bridgeport's front door is one of her assets that inland cities may well envy. The beaches, too, are one of Bridgeport's chief

attractions. Within walking distance of the main business section is Seaside Park, acquired by the city in 1865 through the generosity of P. T. Barnum, the great showman, and here excellent bathing facilities are provided.

Bridgeport's reputation rests chiefly on its leading and varied industries. Bridgeport manufactures some five thousand different articles, and does not depend on one class of manufactured products.

There are 50,000 wage earners in Bridgeport, the largest number in any city in Connecticut. The value of the products manufactured annually is over $170,000,000 and many of these products are known the world over. Among these manufacturers are: Singer Sewing Machine Co., Remington Arms Co., Columbia Phonograph Co., American Chain Co., Raybestos Co., Bridgeport Brass Co., Dictaphone Corp., General Electric Co., Remington Rand, Inc., Underwood-Elliott Fisher Co., Crane Co., Warner Bros. Co., Bassick Co., Bullard Co., McKesson & Robbins, Sikorsky Aviation Corp.

One of the charms of Bridgeport is that a ten-minute ride from the center of the city brings one to real "country"—a series of rolling hills immediately back of the city affording splendid views of typical Connecticut landscape. Several gorges of this wooded area have been made into storage reservoirs by the local water company and are of unusual beauty.

Bridgeport is only two hours from the Litchfield Hills and three hours from the Berkshires. The rugged beauty of the Housatonic and the Naugatuck Valleys, and the more placid beauty of the Connecticut River Valley invite the motorist. Splendidly paved highways run in all directions to the countryside. *On plant visitation day, visitors will have an opportunity to view this beautiful countryside.*

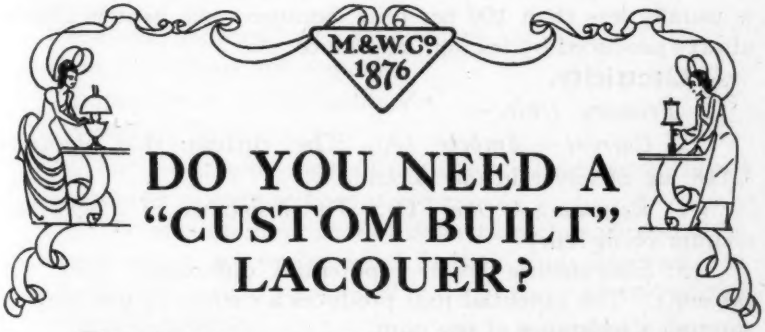
Bridgeport's many excellent hotels insure adequate and comfortable hotel accommodations. Meeting facilities for convention groups are well provided. The Stratfield Hotel, operated on a metropolitan scale with 475 rooms; The Stratfield Annex with 125 rooms; the Barnum Hotel, erected in 1928, with 200 rooms—together with other average hotels of medium size furnish excellent hotel accommodation, and there are also within the radius of a few miles many first-class inns and road houses.

1935 CONNECTICUT TERCENTENARY

Connecticut will celebrate her Tercentenary during the year 1935. Visitors to the State during the summer of 1935 will find much of unusual interest planned for this celebration.

There is much of historic interest in Bridgeport and in the old colonial villages of Fairfield on the west and Stratford on the east. Fairfield is rich in historical interest. There is the stone powder house, the whipping-post on the village green, the Sun Tavern where Washington fed and watered his horses in 1789, and three houses which escaped burning at General Tryon's hands in 1779.

Stratford was settled by immigrants from Shakespeare's birthplace, and it is therefore especially appropriate that in Bridgeport's Beardsley Park there should be erected a duplicate of the famous cottage of Shakespeare's sweetheart in Stratford-on-Avon—Anne Hathaway's Cottage. Several pre-revolutionary houses in Stratford are worth visiting. The Episcopal Church still bears the original chanticleer used for target practice by the Red Coats in 1757.



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Principles of Chemistry

For ELECTROPLATERS

By DR. WILLIAM BLUM

LESSON II

Energy

1. Energy. "Power to do work". Different forms of energy, such as heat, light, mechanical, electrical and chemical.

2. Transformation of energy. Change one form into another. Example — Burn coal (*chemical* energy) to produce *heat*, to operate steam engine (*mechanical*) to turn dynamo (*electrical*) to operate lamps (*light*).

3. Utilization of energy.

Conservation of energy — Energy can neither be created nor destroyed. The theoretical maximum yield in any transformation of energy is determined by the equivalents of the different forms of energy. The efficiency of any specified transformation is usually less than 100 per cent, because some heat is almost always produced by friction, resistance, etc.

4. Electricity.

(a) *Primary Units* —

(1) *Current — Ampere* (A). The current that deposits 1.118 mg of silver in one second.

(2) *Resistance — Ohm* (Ω). The resistance of a specified column of mercury.

(3) *Electromotive Force* — (potential difference) *Volt* (E) (or emf). The potential that produces a current of one ampere through a resistance of one ohm.

(b) Ohm's Law —

$$\text{Current} = \frac{\text{Electromotive force}}{\text{Resistance}}$$

$$I = \frac{E \text{ or } emf}{R \quad R}$$

$$\text{Amperes} = \frac{\text{Volts}}{\text{Ohms}}$$

$$A = \frac{V}{\Omega}$$

Analogous to flow of water

$$\text{Current (rate of flow)} = \frac{\text{Pressure}}{\text{Resistance}}$$

$$\text{Gallons per minute} = \frac{\text{Head of water (feet)}}{\text{Resistance of pipe}}$$

Applications of Ohm's Law —

To calculate the current, divide the voltage by the resistance

$$I = \frac{E}{R}$$

To calculate the resistance, divide the voltage by the current

$$R = \frac{E}{I}$$

To calculate potential, multiply the current by the resistance

$$E = IR$$

The fall in potential in any conductor is known as the "IR" drop.

(c) *Secondary Units* —

(4) *Quantity of Electricity* — One *Coulomb* = one ampere for one second.

1 coulomb deposits 1.118 mg of silver

1 ampere-minute = 60 coulombs

1 ampere-hour = 3600 coulombs

(5) *Faraday's Laws* —

(a) The maximum weight of metal deposited is proportional to the quantity of electricity that passes.

(b) The maximum weights of different metals deposited by the same current are proportional to their equivalent weights. (The equivalent weight of a metal is equal to its atomic weight divided by its valence.)

EXAMPLES

1 — How much silver can be deposited by one ampere-hour?

If one coulomb deposits 1.118 mg of silver, one ampere-hour will deposit

$60 \times 60 \times 1.118 =$

$3600 \times 1.118 = 4024.8$ mg

$= 4.0248$ g of silver

2 — How much copper can be deposited (from copper sulphate solution) by one ampere-hour?

The atomic weight of silver is 108, and its valence is 1, so its

equivalent weight is also 108. The atomic weight of copper is 64, and its valence (in copper sulphate) is 2. Hence its equivalent weight is $\frac{64}{2}=32$.

If one ampere-hour deposits 4.025 g of silver, it will deposit $\frac{32 \times 4.025}{108}=1.19$ g of copper

(6) *Power* — The power used is the product of the potential and the current, that is the product of the volts and amperes.

1 Watt = 1 ampere at 1 volt

1 Kilowatt = 1000 watts

1 Horse-power = 746 watts

1 Kilowatt = 1.34 horse-power

(7) *Energy* — The electrical energy consumed is equal to the product of the power and the time.

1 Joule = 1 watt for 1 second

1 Watt-hour = 1 watt for 1 hour

1 Kilowatt-hour = 1 kilowatt for 1 hour

5. Electrolysis.

(a) *Parallel* arrangement of tanks — All anodes are connected to one side of the generator, and all cathodes to the other side. The voltage is the same on each tank. The current in each tank is inversely proportional to its resistance.

Example — If three tanks, A, B, and C, in parallel, have resistances respectively of 0.06, 0.03, and 0.01 ohm, and 6 volts is applied, what current will pass through each?

A $\frac{6}{0.06}=100$ amperes

B $\frac{6}{0.03}=200$ amperes

C $\frac{6}{0.01}=600$ amperes

(b) *Series* arrangement of tanks — The anodes in one tank are connected to the cathodes in next tank. The same current passes through each tank. The voltage across each tank is *directly* proportional to its resistance.

Example — If the same three tanks are connected in series and 6 volts is applied, (a) what current will pass and (b) what will be the voltage drop in each tank?

(a) The total resistance is equal to $0.060+.03+0.01=0.10$ ohm. Hence the current will be equal to $\frac{6}{0.10}=60$ amperes.

(b) The IR drop in each tank will be

A $60 \times 0.06=3.6$ volts

B $60 \times 0.03=1.8$ volts

C $60 \times 0.01=0.6$ volts

(c) Three wire system — This is used with a double commutator generator. Each tank is usually operated at either 6 or 12 volts. It is necessary to balance the currents on each side, so as not to exceed the capacity of each commutator.

6. Heat is produced by the flow of current through a resistance.

1 *calorie* is the quantity of heat required to raise the temperature of one gram of water one degree centigrade.

1 *B. T. U.* (*British Thermal Unit*) is the quantity of heat required to raise the temperature of one pound of water one degree Fahrenheit.

1 B.T.U. = 252 calories

1 joule = 0.239 calorie

1 watt hour = 860 calories

1 kilowatt hour = 860,000 calories = about 3400 B.T.U.

Energy used = Heat produced

I.E.t. = current + voltage + time = Heat

Amperes + volts + seconds = Heat (in joules)

Amperes + volts + seconds + 0.239 = Heat (in calories)

I^2Rt = amperes + amperes + ohms + seconds + 0.239 = Heat (in calories)

Hence doubling the current produces four times as much heat.

If the resistance is reduced to one-half and the *current* is kept constant, one-half as much heat is produced.

If the resistance is reduced to one-half and the *voltage* is kept constant, the current is doubled, and the heating is also doubled.

Problems — Lesson II

1 — Suppose you install a 6 volt, 1000 ampere generator.

(a) Assuming 100 per cent efficiency for both the motor and generator, what horse-power motor will be required?

(b) Assuming 75 per cent efficiency for the motor and 80 per cent efficiency for the generator, what horse-power motor will be needed?

(c) Under the conditions of (b) how much will it cost per hour to run the generator set at full capacity if the price of electricity is 2c per kilowatt hour?

2 — Suppose the voltage at the generator is 6 volts, and at the tank is only 5 volts, when a current of 100 amperes is passing to the tank. What is the resistance in ohms of the circuit from the generator to the tank?

3 — Suppose that the voltage at the tanks is 6 volts, and that the respective resistances of three tanks in parallel are A, 0.05 ohm; B, 0.02 ohm; and C, 0.03 ohm. What current will pass through each tank?

4 — Suppose that with the same parallel tank resistances as in 3, it was desired to pass 100 amperes through each tank. What voltage must be applied to each (for example by control with tank rheostats?)

5 — Draw on a separate sheet a wiring diagram of your plating room, showing the relative positions and connections of (a) generators, (b) ammeters, (c) voltmeters, (d) rheostats, and (e) tanks.

6 — Suppose in silver plating you have deposited 100 troy ounces of silver. (One troy ounce = 31 grams). Assuming that the current efficiency is 100 per cent, that the generator is running at 6 volts, and that the cost of electricity as delivered by the generator is 5c per kilowatt hour, how much did it cost for current to deposit the silver?

Hans A. Gilbertson

It is with deep regret that we report the death of Mr. Hans A. Gilbertson, father of our Supreme President, Mr. H. A. Gilbertson.

Although he was not a member of the A. E. S., he was very much interested in its progress. Mr. Gilbertson was well known to many of our members and took an active interest in the plating business, especially in the jewelry line, being a silversmith.

The death took place on Jan. 22, burial Jan. 26, at Mt. Olive cemetery.

On behalf of our membership we convey to the family of the deceased, our sincerest sympathy in their time of sorrow.

The **Structure** *of Polished Metal Surfaces*

By WALTER R. MEYER,
Electro-Chemist
and
CLARENCE C. HELMLE,
Analyist
General Electric Co.,
Bridgeport, Conn.

THE works of Sir George Beilby[1] have undergone extensive scrutiny during the last five years especially due to the invention by G. P. Thomson[2] of the Electron Diffraction Camera. The proper understanding of the nature of polished metal surfaces requires, as a prerequisite, a knowledge of crystal structure and of the forces which determine cohesion in solids. This paper aims to present our state of knowledge on the controversial subject of the structure of the Beilby layer and the condition of the metal between this layer and the undeformed basis metal. The nature of cohesion in solids, crystallinity, and intercrystalline boundaries are reviewed. The effects of the structure of the polished surface on electro-deposits are considered. The term "polishing" includes the terms "polishing", "buffing", and "color buffing" of trade practice.

COHESION IN SOLIDS

The effects of cold working, grain size, impurities and physical and chemical influences on the technical strength of metals are well known. The nature, however, of ultimate cohesion, interatomic attraction, is still in the realm of speculation. It will be observed that the cohesional properties of pure metals are determined by the electronic arrangement in the atoms, as they vary periodically with the atomic number.

The strongest elements show high chemical affinity, high latent heat of evaporation, high melting point, low coefficient of expansion, low atomic volume and low coefficients of compressibility. In some cases, the major forces are electrical in nature

as in the alkaline halides. Electric attraction cannot alone account for stability as the two atoms might theoretically coalesce, hence a repulsive force must also be present. The stability of the lattice requires additional balancing forces. The forces between inert gas atoms particularly, and the forces exerted outside a crystal surface are termed Van der Waals forces and are due to the electronic systems of the ions apart from the net electrostatic charges of the ions.

Two types of cohesion may be assumed to exist; the "homopolar", and the "metallic" types. In the homopolar type, the arrangement of atoms is rendered stable by electron-sharing for example, the diamond. In the metallic type, the positive metallic ions are held in equilibrium by mutual interaction with a "gas" of electrons.

In summary, forces of attraction and repulsion exist between the atoms and as Joffe[3] states, "for stable equilibrium in an expansion of the crystal as a whole, the attraction forces must predominate between the units, while in compression the repulsive forces must predominate". The molecular or theoretical cohesive strengths of metals are enormous, being in many cases, between 50 to 100 times the technical rupture strength. The orientive forces working on the torn crystallites resulting from polishing are powerful. Plastic flow is greatest with low cohesion as is evident in the ease of buffing lead, zinc or tin against the difficulty with chromium.

CRYSTALLINITY

As a metal is cooled and changes from the liquid to the solid state, the rapidity of vibration of the molecules is decreased so that the orientive forces come into play and a regular or lattice structure is set up. The energy given off in the transition of a liquid to a solid is called its latent heat of crystallization. If an "amorphous" solid results, it must retain the energy of this latent heat. Thermodynamically the change from an amorphous state to the crystalline state should occur more readily than the reverse! The amorphous state is regarded as an arrangement of atoms or molecules in which the orientive forces are either non-existent or cannot make themselves evident due for example, to low atomic mobility. An increase in temperature increases

atomic mobility which in turn promotes crystallinity. In the crystalline state, in contrast with the amorphous or liquid state, the physical properties are vectorial and the state is anisotropic. The properties of an amorphous material are non-vectorial or isotropic.

The truly amorphous solid state is not common. Until recently, this term was applied when no crystallinity could be observed under a powerful microscope. The methods of x-ray and electron diffraction have shown the crystalline or semi-crystalline state to exist in many substances long thought to be amorphous. Orientive forces[4] have been found in grease, stretched rubber, glass, "amorphous" carbon blacks, and in liquids. Liquid crystals or liquids with anisotropic properties are usually organic molecules whose lengths are much greater than their width.

Complete break-down to a monatomic liquid evidently does not occur on melting of a metal. Experiments[5] on the correlation between superheating and undercooling lead to this conclusion. Zwicky's[6] crystal block theory is used to explain the phenomenon. Small blocks of the crystals are assumed to exist in the molten state just above the melting point. These will act as nuclei for crystallization and hence prevent undercooling. If the liquid is heated to a higher temperature, these blocks are destroyed and the undercooling will be greater. In view of the above, it would be difficult to conceive of a truly completely amorphous state resulting at the low temperatures of polishing or buffing.

INTERCRYSTALLINE BOUNDARIES

No satisfactory method has been devised for the investigation of atomic structure in the intercrystalline boundary. Two extreme views are possible, namely; crystal abutment without lattice distortion or the presence of an "amorphous" cement. Neither view seems tenable, as an atom in between would be under the orientive influence of each lattice structure. A curved lattice with a gradual orientation might be suggested.

Based on the x-ray analysis of cold worked metals, Gough[7] suggests that the transition from crystal to crystal is effected by a number of small crystallites of slightly differing orientation, their structure being substantially free from lattice distortion but having strained or ruptured atomic bonds at the junctions.

Tamman[8] regards the boundaries in cast metals as consisting essentially of impurities.

As a result of wire drawing experiments, it was found that the limiting stage of crystal break-up represents an arrangement of crystallitesof lengths of the order of 10,000 inter-atomic diameters or .0002 cm. This value is interesting in that it agrees with the value of Zwicky's blocks. Smaller grain size and resultant increase in grain boundaries cause increased strength by inhibiting slip.

BEILBY'S THEORY

In May, 1911, G. T. Beilby[9] in his paper "The Hard and Soft States of Metals" started a controversy that has extended some twenty-odd years. He recognized the skin-like structure formed on polishing as well as the change in hardness, electrical and chemical properties. The effects of cold working and plastic flow were explained on a basis of the formation of "amorphous" metal. Rosenhain and Jeffries have modified Beilby's theory but the assumption of the presence of amorphous material has been retained. In the conclusion of his paper, Beilby stated, "the crystalline state is the state of minimum mechanical stability and of maximum thermal stability".

The "amorphous" theory has met with many objections. It is difficult to assume the presence of considerable quantities of amorphous metal at temperatures so far below the melting point. Whereas[10] a metal hardens during tension, reversal of the applied stress, namely compression following stretching, shows less hardening as compared with the original state. Anisotropism or directional properties would have to be assumed in the amorphous, isotropic cement.

According to Tamman[11], the assumptions that plastic flow is accompanied by transient melting due to pressures below 1000 kg. are untenable. Assumptions of the formation of a new phase, as is done when amorphous matter is assumed to have been formed, is in conflict with the phase equilibrium laws in three ways; "(1) Assuming a phase change in fields of existence where it cannot occur, (2) reaching a conclusion which would involve opposite volume changes from the observed ones, and (3) by assuming a phase change, one is still not able to explain the

difference in the action of a hydrostatic and an inhomogeneous pressure field."

W. A. Wood[12], of the National Physical Laboratory, using monochromatic x-rays has reported the following effects of cold working: (a) Crystal break-up in which the original grains are broken up into smaller crystallites of sizes from .001 cm. to .0001 cm. (b) Lattice distortion. (c) Fiber structure in which the random orientation of the crystals is changed to preferred orientation and (d) variation of electronic distribution around the atoms. At air temperatures, pure metals or alloys seem to be incapable of crystal break-up beyond the limit of crystallites whose lengths are of the order of 10,000 interatomic dimensions. Let it be understood, however, that the x-ray penetration is much greater than 10^{-6} cm. and hence these results are not of a surface condition alone but of the interior as well.

The transcrystalline fracture of metals at low temperatures could be explained on the assumption of the crystallites for ntercrystalline cement. The ratio of the amount of grain boundaries to volume of metal would be much greater with the intergranular material than with the grains themselves. Aston[13] has found from x-ray investigations that the deformation, from stresses, of the grain was extremely small near the boundary and the boundaries consequently inhibited slip. Therefore the intergranular crystallites would have greater strength than the grains and the fracture would be transcrystalline.

INTERNAL FLAW OR MOSAIC STRUCTURE OF CRYSTALS

The experimental rupture strengths of single crystals are from 1/10 to 1/100 the theoretical values. To account for this deviation, various investigators have assumed the presence of minute flaws or cracks in the crystal giving rise to a mosaic structure. H. Siedentopf[14] in 1905 indicated that pores or cavities existed in the lattice. Joffe, Smekal, Griffiths and Zwicky have elaborated on the idea that actual crystals are never ideal geometrical structures. In defense of their views, it has been found that the experimental rupture strength increases as the diameter of the test specimen decreases and the strength extrapolated to zero diameter approaches the theoretical rupture strength.

It may be questioned, however, whether observed rupture strengths are really abnormal, for the calculated theoretical strengths assume that all the atom bonds are uniformly strained immediately preceding fracture, whereas actual failure is usually preceded by plastic deformation.

G. P. Thomson[15] has studied the mosaic theory by means of electron diffraction analysis. Making use of Kikuchi lines, whose sharpness indicates the "perfectness" of a crystal, he concludes that the blocks of the mosaic structure can be in the same plane as the crystal face or be tilted to a slight degree and the coherent regions on the surface must be at least of the order of .00002 cm. Further mention will be made of the mosaic structure in the discussion of polished surfaces.

POLISH ON METALS

R. C. French[16] has used the electron camera for the investigation of mechanically worked surfaces, studying the polishing effects on copper, silver, gold, and chromium. The electron ray is preferable to the x-ray because of its low penetrating power, being not more than .000001 cm. Thus the diffraction and refraction effects are due to a surface condition. French concludes that highly polished (buffed) surfaces are almost amorphous and because he finds "amorphous" or diffuse rings of the same diameter for a number of different metals, the surprising conclusion is drawn that the spacing of atoms in the polished layers is the same. These metals have quite different atomic densities in the crystalline state! Reasons are given for concluding against Professor Kirchner's[17] views that the absence of a sharp diffraction pattern is due to a leveling in polishing of fins sufficiently thin for passage of electrons.

L. H. Germer[18] offered objections to French's conclusions that a polished layer is amorphous, based on electron diffraction studies of drawn wires. Germer attributed the diffuse patterns of polished surfaces to line broadening and overlapping due to angular small scale variation.

Darbyshire and Dixit[19] confirmed French's findings for the same and other metals. They conclude also that the atoms in the polished layer undergo a very close packing, with interatomic distances much smaller than the distances in the crystal

lattice. The abnormally small size of the atoms is believed to be due to stripping of electrons from the outer electronic shell (by polishing). They obtained no support for the Beilby theory for heteropolar binding such as in Galena or Pyrites.

Finch, Quarrel, and Roebuck[20] in a recent paper on the diffusion of condensed zinc vapor into polished and unpolished copper, believe their experiments offer positive evidence of the existence of the Beilby layer. We do not agree with their conclusions. The rapid diffusion of zinc into the polished layer with little or no evidence of crystal structure in comparison with the crystallinity and persistence of the zinc on etched copper can be explained other than on the assumptions of the amorphous state. When the receiver is glass or an oxide the finely dispersed state may persist for some time at room temperature although there is a tendency for crystallization. When the receiver (copper), has a polished surface the metastable crystallites of the polish will either catalyze a recrystallization of the sublimed deposit or form an alloy with it. This the authors have observed. If the polish is etched off the face of the receiver, it consists of relatively much larger crystals which will not allow the sublimated deposit (zinc) to diffuse as rapidly. Diffusion experiments in the literature indicate more rapid diffusion along grain boundaries than through the grains. It is unsound thermodynamically to assume that an initially crystalline state (as the authors find), will spontaneously change into an amorphous phase at room temperature or as Dixit[21] claimed with evaporated silver films, that prolonged heating destroys crystal structure. Such conclusions lessen our confidence in other conclusions in this field.

Ewing, Publow and Tuttle[22] in a study of electro-deposited chromium on polished, unetched steels found that deposition first took place on the cementite areas and followed the crystal boundaries of the structure of the basis metal. It is possible that the chromium solution may have slightly etched the so-called "amorphous" film during the plating process to expose the larger crystals beneath.

L. Hamburger[23], of Holland, in a very able paper printed in German, reconciles the "amorphous" and crystalline viewpoints based on microscopic "development" of polished surfaces. His views may be summarized as follows:

1. Polishing (buffing) is primarily a chip removing process accompanied by absorption effects. The size of the chips is between three atoms and 30 atoms.

2. In a later phase of polishing, a portion of the "flowing" amicrons adhere to a portion of the worked surface notably in little holes and crevices. Actual melting of the surface is not implied. In the resultant mirror-like surface, the mean particle size is small in comparison with the wave length of visible light but large in relation to atomic dimensions.

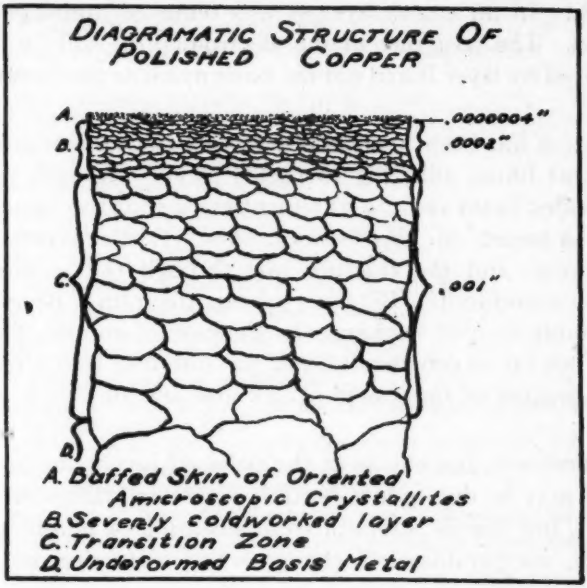
3. The carefully polished (buffed) surface of a crystalline substance at room temperature consists of laminae of oriented crystallites of amicroscopic magnitudes which show a frequency of particle size. The polish extends inward to the basis metal by a transition layer of larger crystals. The nature of the polished layers is complicated through absorption, impurities, the presence of distorted transition zones between the crystallites, and more generally by a physical metastability. Hamburger's interpretation would account for diffuseness of the electron diffraction patterns because of the poor resolving power of the micro-crystals. The micro-crystals are assumed to be due to the blocklets of the mosaic structure previously discussed.

There is no question that the surface is under great stress and has the characteristics of grain boundaries. Phillips and Brick[24] found that the solubility of copper in aluminum was markedly decreased on the polished surface to a point much below that required by the equilibrium diagram. Large amounts of $CuAl_2$ were precipitated from a 5% copper-aluminum alloy in the polished surface.

SUB-SURFACE EFFECTS OF POLISHING

The amount of sub-surface crystalline distortion depends upon the force and abrasive used in polishing as well as the strength and the annealing temperature of the metal concerned. In the polishing of lead for example, few if any, strains are set up in polishing in spite of its low strength because of its low crystallization or annealing temperature.

Following is a diagram illustrating the effects of polishing copper based, in part, on x-ray data of W. Boas and E. Schmid[25].



The diagram cannot do justice to the actual relative sizes of the various layers. The ratios of thicknesses of A, B, and C layers are respectively 1, 500, and 2500. Note that distortion effects penetrate more than one-thousandth of an inch below the surface and that the transitions from A to B and B to C are sharp but the change from C to the basis metal D is gradual.

EFFECTS OF POLISHED LAYER ON ELECTRO-DEPOSITS

The statement has been repeatedly made in the literature that the "amorphous" skin from polishing prevents the growth of the crystals of the basis metal by the electro-deposit. It was shown, however, that copper electro-deposited upon bright-dipped copper, resulted in an extension of the grains of the basis metal. The crystal-growth inhibiting effect of the buffed layer is not due to an "amorphous" layer. Firstly, we follow Hamburger's viewpoint that the layer is micro-crystalline and secondly, we have determined that this layer is removed in the commercial processes of cleaning buffed metal prior to plating. Brass, copper, lead, zinc and steel were immersed 3 minutes in an alkaline cleaner, dipped 5 sec. in 20% HCl and then 5 sec. in 3% sodium

cyanide. In all cases, layer A was removed and layer B was exposed. The structure of the electro-deposit will be therefore influenced by layer B and not the basis metal or the "amorphous" skin.

Mention has been made of Hothersall's experiments in which brass was found adhering to peeled nickel originally deposited upon buffed brass and the statement made that the "amorphous" skin was peeled off. We believe, however, that layer "A" was not present and the fracture was through the severely cold-worked, non-ductile "B" layer of our diagram. Brass is very susceptable to cold working. In the case of copper, the effects would not be so pronounced and for zinc and lead almost negligible because of rapid acid attack and low annealing temperatures.

In summary, the effects of the polished layers on the electro-deposit may be due to low ductility, increased diffusion (zinc on copper), low tensile strength from smearing of non-metallic inclusions, recrystallization changes, and reduction of area of contact.

In conclusion, may we state that brevity precludes a more detailed exposition of the relationships between the subject matter prior to "Polish on Metals" and the subsequent subject matter. This we leave to the reader with the hope that our exposition will render a clearer insight on the structure of polished metal surfaces.

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Publications *on* *Electrodeposition* *from the National Bureau of Standards*

Revised to December 1, 1934

THE principal activities of the Bureau in the field of electrodeposition are as follows:

1. Researches upon the fundamental principles of electrodeposition.

2. Studies upon the quality and value of electroplated coatings and the development of specifications for use by the Government and industry.

3. The development of special processes and equipment required by other branches of the Government, such as the War, Navy, and Treasury Departments.

4. Investigation of the methods of testing electroplated products and the solutions used in electrodeposition.

5. Testing of electroplated metals, such as hardware and plumbing fixtures, that are purchased by the Federal Government on specifications. (Tests are not made for the general public.)

6. Furnishing information to the Government and the public. Requests for information in this field that are not covered by the inclosed publications will receive careful attention.

In all the above activities the Bureau cooperates directly with other Government agencies and with appropriate technical organizations, such as the American Electro-Platers' Society, the International Association of Electrotypers and the American Society for Testing Materials.

The publications from the National Bureau of Standards in this field are divided into two parts:

List "A" includes in chronological order those papers published by the Government, most of which may be obtained by sending the list price (not stamps) to the Superintendent of Documents, Government Printing Office, Washington, D. C. Do *not* send money to the Bureau of Standards. Where no price is indicated, the papers are no longer available by purchase. Files of the Government publications will be found in the larger libraries.

The explanation of the serial letters used for designating the separate papers of the Bureau is as follows:

RP ="Research Paper". These are reprints of articles appearing in the "Bureau of Standards Journal of Research" (BSJ. Research) and the "Journal of Research of the National Bureau of Standards" (J. Re-

search NBS), the latter being the title of this periodical since July, 1934 (volume 13, number 1).

S ="Scientific Paper" of the National Bureau of Standards. From Nos. 1 to 329, inclusive, the separate papers of this series were known as reprints from the "Bulletin of the Bureau of Standards" (Bul.BS). Subsequently, from nos. 330 to 572, the separates were known as reprints from the "Scientific Papers of the Bureau of Standards" (Sci. Pap.BS). This series was superseded by the "Bureau of Standards Journal of Research" in 1928.

T ="Technolgic Paper" of the National Bureau of Standards. Nos. 1 to 202 were issued each independent of the other with individual pagination. Later they were assembled to make the first 15 volumes of this series, and subsequent separates were given volume pagination. (Tech.Pap.BS). This series was superseded by the "Bureau of Standards Journal of Research" in 1928.

C ="Circular" of the National Bureau of Standards.

PHR=Public Health Reports, issued by the U. S. Public Health Service of the Treasury Department.

FS =Federal Specification.

List "B" includes those papers that have been published in outside journals, files of which are available in many libraries.

For convenience a list "C" is added, which includes journals and books printed in the English language that contain information on electrodeposition.

The index contains the principal subjects referred to in the publications of "A" and "B".

III. PUBLICATIONS

"A" — Published by the Government.

1916.

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	5c	FF-H-106 - Lock and lock trim
	10c	FF-H-111 - Shelf and miscellaneous
	5c	FF-H-116 - Hinges
	5c	FF-H-121 - Door closers

1934.

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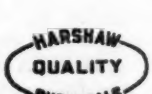

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Monthly Review—American Electro-Platers' Society
Journal Depositors' Technical Society (London)
Metal Industry (New York)
Metal Industry (London)
Brass World
Metal Cleaning and Finishing
Electrotypers' Bulletin
Transactions of the Electrochemical Society
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H. F. Droeger

Mr. H. F. Droeger, plating supervisor of the Mills Novelty Co. for the past 36 years and a member of the Chicago Branch, died January 21, and was buried January 24, at St. Lucas Cemetery, Chicago, Ill.

The Abstract Section

T. F. SLATTERY, *Chairman, Program and Educational Committee*

The Nickle Plating of Aluminum. W. FRÖLICH. Die Metallborse, **24,** 405-06, 439, 469-70 (1934).—This paper is essentially a review of selected articles on the subject. Rapid oxidation of aluminum and its relatively negative electrolytic potential make plating on it difficult. Preparation for plating is accomplished by: (1) mechanical removal of impurities; (2) chemical cleaning; (3) removal of oxide layer; (4) etching; (5) metallizing (to prevent deposition by immersion). Soft brushes with warm soap solution or prepared chalk paste are used in (1) for the first cleaning, as steel brushes and sand blasting are not suitable. Chemical cleaning (2) is essential and is done in alkaline solutions with a pH of not over 10. The temperature in cleaning is important and critical, it is optimum at 205° F (just below boiling), where 212° F would cause failure. Soap solutions are satisfactory and may be strengthened by alkaline additions. A mildly acting solution with from 3 to 6 oz/gal of sodium bicarbonate may be prepared. (NOTE—This decomposes partly to form sodium carbonate when heated to 195° F. Abst.) A milder solution consists of 1 to 3 oz/gal each of sodium carbonate and trisodium phosphate; both solutions being used at 195-205° F. Chromates and silicates act as "inhibitors" to reduce corrosion of the aluminum, and borates and phosphates facilitate rinsing. Additions which temper the action of stronger alkalis are sodium aluminate, trisodium phosphate, and waterglass, which permit the use of hydroxide if otherwise necessary. The composition, concentration and temperature of the cleaner are adjusted by small scale tests to give good results with 1 to 1½ minutes immersion. Contrary to usual practice, rinsing must be done first in hot water and then in cold, to prevent oxidation and staining of the surface. One of the following acid dips (3) is usually applicable: (a) dilute nitric acid; (b) 1 part hydrofluoric (45%) acid in 9 parts water, (15 sec.); (c) concentrated nitric acid, (3-5 sec.); (d) 2 parts nitric acid to 1 part concentrated sulphuric acid (for heavy castings). The most important steps in the process are etching (4) and metallizing (5), which may be combined. Skill and experience are necessary to secure good results with different alloys. Solutions of metals in acids are used. A solution containing 1 part of iron in 500 parts each of concentrated hydrochloric acid and water is unsatisfactory, giving a rough nickel plate. Frölich recommends a cadmium solution composed of 3.2 fl.oz/gal of hydrochloric acid, 3 oz/gal of cadmium chloride, and 0.7 oz/gal

of ammonium fluoride, with 15 seconds immersion. Quick washing and immediate plating at 5 amp/ft² is advised in a nickel plating solution containing 7 oz/gal of nickel sulphate and 5 oz/gal of sodium citrate, which is to be used only after the cadmium dip. Bright, adherent, polishable nickel is obtained. A nickel solution for metallizing that contains 30 oz/gal of nickel chloride and 15 fl.oz/gal of hydrochloric acid is used at 185° to 195° F for 15-30 seconds. A similar solution for pure aluminum, containing 29 oz/gal of nickel chloride and 24 fl.oz/gal of hydrochloric acid is used at 95° F for 15-30 seconds. For wrought and rolled alloys a solution that is sometimes effective contains 0.7 oz. of manganous sulphate dissolved in a gallon of a mixture of 1 part concentrated hydrochloric acid and 2 parts water, this is used at 95° F for 15-30 seconds. For casting alloys, metallizing is sometimes omitted and etching is done at room temperature in a mixture of 1 part hydrofluoric and 3 parts nitric acid, for 15-120 seconds, the longer time being required by sand castings. A nickel bath suitable for plating directly on aluminum contains 15 oz/gal of nickel sulphate, 8 oz/gal of magnesium sulphate, 4 oz/gal of ammonium chloride, and 4 oz/gal of boric acid, which is used at 85 to 95° F, a pH of 9.8-6, and a current density of 15 amp/ft². Flash deposits of brass, copper and zinc do not improve subsequent nickel plating in proportion to the added trouble and expense and are only of technical interest, since nickel plating directly on aluminum can be made satisfactory. Brass plating (see A. V. Re, Trans. Electrochem. Soc., **61**, 337 (1932)) gives good results. Zinc is harmful to the nickel plate and should be used only for its own protective action; the heat treatment of zinc-nickel coatings on aluminum can yield good results but the process is too complicated and sensitive to be practical. Nickel plated aluminum cooking utensils, etc., can be improved by heat treating them as follows: 1-2 hours at 248° F, slow heating to 392° F, and several hours annealing at 392° F, followed by slow cooling.

R. M. WICK.

New Experiences in the Field of Electrodeposits. A. POLLACK, Chem, Ztg. **58**, 997, 1934.—This article is a concise but comprehensive review of modern methods of electroplating, which includes references to practice in Germany, France, and America. It can not be readily abstracted, but deserves reading by those able to read German. It covers cleaning and pickling, rapid nickel plating (including "bright" nickel and plating on aluminum), chromium, cadmium and zinc plating and barrel and automatic plating. W. BLUM

Studies in Zinc Electrodeposition; Deposition from Ammonium - Sulphate - Zinc Baths. RAYMOND R.

ROGERS and EDGAR BLOOM, JR. Trans. Electrochemical Soc. **67**, preprint 8, 1935 (To be presented at the New Orleans Meeting, March 21, 1935).

A survey was made of the conditions under which zinc may be deposited from solutions containing zinc sulphate and ammonium sulphate, with either an excess of sulphuric acid (acid baths) or of ammonia (alkaline baths). The results are plotted in diagrams which show the compositions within which zinc can be deposited under some conditions of temperature and current density. The best deposits from acid solutions were obtained in a bath containing 33 oz/gal of crystallized zinc sulphate and 16 oz/gal of sulphuric acid at 80° F and 150 amp/ft^2. The best deposits from alkaline solutions were obtained in a bath containing 13 oz/gal of zinc sulphate, 13 oz/gal of ammonium sulphate and 23 oz/gal of ammonium hydroxide (sp.gr. 0.90); at 28 amp/ft^2 and 104° F. W. BLUM

Electrolytic Deposition of Copper-Nickel and Iron Alloys. By H. PAWECK, J. BAUER, J. DIENBAUER. *Zeitschrift für Elektrochemie*, Vol. 40, No. 12, 1934, pages 857-862.—Attempts were made to deposit an alloy of copper-nickel-iron of the composition of monel metal from a non-cyanide solution. It was determined that the deposition of such a ternary alloy could actually be accomplished from a simple sulfate bath by the addition of sodium citrate. Through the variation of the components of the electrolyte and the current density, any desired composition could be obtained. Such baths may find special application but the close control required would preclude their use on any extensive scale. WALTER R. MEYER

Overvoltage and Cathodic Embrittlement of Steel. (Überspannung und Kathodische Brüchigkeit des Stahls by D. ALEXEJEW and P. PERMINOW.—In previously published works, it was shown that the entry of cathodic hydrogen into steel could not occur when pure sulfuric or phosphoric acid was used and the entry was induced by certain catalysts as arsenic or antimony oxide, hydrogen sulfide, sulfur dioxide, etc. The hydrogen enters the steel in the atomic form.

To determine whether cathodic overvoltage was the determining factor in hydrogen absorption careful measurements were made with various concentrations of H_2S added to the electrolyte. H_2S was found to lower the overvoltage but arsenic raised the overvoltage. From their experimental results, the authors conclude that the formation of hybrides is the determining factor for hydrogen absorption in steel and the resulting embrittlement. WALTER R. MEYER

The Influence of Overvoltage of Cathodic Hydrogen on the Strength of Different Steels. By TIBOR KRASSO. *Zeitschrift für Elektrochemie*, Vol. 40, No. 12, 1934, pages 826-829.—The author carried out investigations on the effect of cathodic hydrogen on various kinds of steels. In contrast with Alexejew's work, embrittlement was noted in pure sulfuric acid solutions with certain alloy steels. Nickel steels with nickel contents from 5% to 16% and chromium from .5% to 1.2% were easily embrittled by cathodic hydrogen in the absence of a catalyst. These steels have high hydrogen overvoltages.

Krasso concludes against the hybride theory of Alexejew and believes the embrittlement catalysts' function is the raising of the hydrogen overvoltage. WALTER R. MEYER

Bullard-Dunn Process Used to Clean Car Parts. Anonymous. *Iron Age*, Vol. 134, No. 15, p. 28-30.—A description is given of the sequence of steps used on a conveyer to clean steel parts by this process. Total time required varies from 30 to 100 minutes depending on difficulty of cleaning. The sequence is Caustic, spray rinse, Electroplate, spray rinse, Caustic, spray rinse, Electroplate, spray rinse, Caustic rinse, hot rinse, load and unload. Caustic is a hot Na_3PO_4 & NaOH solution work as anode 75 amps. per square ft.

Electroplate 24 oz./gal. H_2SO_4, 6 oz./gal. Na_2SO_4 2% tin, tin anodes, work cathode, 150° F. CD-65 amps. per square ft.

E. T. CANDEE

New Type Solvent Machines Used to Clean Metal Parts. G. E. POWERS. *Iron Age*, Jan. 17, 1935, Vol. 155, No. 3, p. 31.—A general description is given of machines used for solvent degreasing. The methods include immersion of the work in the vapors of the solvent, immersion in the boiling solvent and spraying of the solvent on the work to remove solid particles.

The material used is stabilized chlorinated solvent (trichlorethelyne.—Ed.).

Machines are designed for hand cleaning and automatic cleaning. E. T. CANDEE

Improved Coating Applied to Wire by Electrogalvanizing. Anonymous. *Steel*, Dec. 24, 1934, Vol. 95, No. 26, pages 22-24.—A description is given of the deposition of zinc on wire known as Bethanizing. Wire is lead annealed, electrolytically cleaned in fused caustic soda, electrolytically cleaned in acid and plated at 700-1400 amperes per square foot at 20 volts. Insoluble anodes are used. Zinc is supplied by leaching roasted ore with sulphuric acid and purifying the solution. Five illustrations. Few details. E. T. CANDEE

Losses from Recovery Rinse Tanks. By JOSEPH B. KUSHNER. *Metal Industry*, Jan. 1935, Vol. 33, No. 1, pages 14-16.—The purpose of the article is to show that where precious metals are being deposited, the rinse tank, commonly known as a "metal recovery rinse tank", may in reality become a "metal losing tank."

It is shown that after a large number of rinses the total amount of metal lost down the drain is given by concentration of the metal in the plating solution into the product of the drip and the number of rinses minus the volume of the water. Typical problems are given to prove that by following a combination of the ideas and precautions outlined, the losses may be reduced to a negligible minimum. T. F. SLATTERY

A Bit of Logic on the Subject of Plating with Nickel and Chromium. ANDRE DARLEY. *La Metallurgie* (Paris) Nov. 17, 1934, p. 54.—The author blames the depressed condition of the plating industry in France upon the alleged break down of imported automatic plating systems, stating that automatic machinery for plating has failed utterly in operating at high currents and in reducing plating losses and hand-work. He advocates rejection of these systems and the development of a technique more fitted to their needs, based upon established plating practice. Many of his colleagues, whose papers will be abstracted later, do not share in these views. C. T. THOMAS

Micrographic Study of the Adherence of Electrolytic Deposits. M. CYMBOLISTE. *Bull. Soc. Fr. des Electriciens.* Nov. 1934, p. 1137.—General types of adhesion between supporting metals and plated coatings are discussed, and are illustrated by diagrams and micrographs. In discussing causes of poor adhesion, the general statement is made that, if the initially deposited coating is not imperfect and if there are no intermediate films of foreign matter, then the adhesion will be limited only by the strength of the weaker of the two metals in contact. The strength of the surface film of the supporting metal may be weakened in the cleaning or pickling of that surface, or by electrolysis itself, if the preparation for plating is not carefully planned and controlled. Such weakening of the surface lowers the adhesion. The effect of strains in the deposit is also noted. C. T. THOMAS

The October 1934 issue of the *Revue du Nickel*, comprising a symposium on nickel plating, contains the following papers:—

Nickel Plating: Developments in Technique and Methods of Control. J. COURNOT. pp. 158-9.—(Short commentary

on the evolution of present-day plating practice and of methods of test for the standardization of quality in the plated product.)

The Use of the Microscope as a Means of Controlling the Properties of Heavy Eelectrodeposited Coatings. The Importance of Regularity in the Crystaline Structure. M. CYMBOLISTE. pp. 160-4.—(Discussion of variation in structure as affected by conditions of deposition, surface conditions of the basis metal, inclusions caused by impurities, etc. The paper is illustrated by 15 micrographs of satisfactory or defective deposits.)

The Development of High Current Density Nickel Plating in France. BOURGEOIS. pp. 165-71.—(An account of the technique of rapid nickel plating, with illustrations of typical plants working at high current density. Some industrial applications of rapid nickel plating are indicated.)

Heavy Electrodeposits of Nickel and their Applications. A. E. WILSON. pp. 173-7.—An account of the properties obtainable in thick nickel plating, with special reference to heavy coatings deposited by the "Frescol" process. The use of such plating for the building up and reinforcement of engineering parts and for protection against corrosive attack is illustrated by reproductions of crushing machinery, rudders, paper rolls, and other components carrying heavy nickel plating on exposed sections.)

Electrodeposition of Nickel from Solutions of pH above 7.0. M. BALLAY. pp. 178-9. **The Electrodeposition of Bright Nickel Plating in the Presence of Colloids.** pp. 179-81. **Nickel Plating of Aluminum.** pp. 182-3.

—*The Nickel Bulletin*, No. 12, Vol. 7, December, 1934.

In the Membership Drive, Detroit still leads with 12; Chicago, second with 9; Balto-Washington, third with 7. St. Louis added 1 and Montreal got started. There are still 11 Branches holding the goose egg. **See page 63.**

Business and Social News

BRANCH NEWS

Educational Activities

AMERICAN ELECTRO-PLATERS' SOCIETY

MILWAUKEE BRANCH

The Milwaukee Branch held its regular business and educational meeting on Thursday, January 11, 1935. On account of the illness of Secretary Frank Marx, Dan Wittig was appointed to act as secretary for the evening. The meeting was well attended. It seems as if our younger members are putting a little life into the educational meetings. There have been several very interesting subjects at our recent educational meetings.

The application of John Miczewski, Jr., was received for active membership. He is the son of one of our old faithful members, John Miczewski of the National Plating Works.

The committee appointed for our coming Educational Meeting and Smoker have not started on the regular work.

There will be quite a delegation going to the Chicago Educational Session and Dinner. FRANK MARX.

BOSTON BRANCH

Boston Branch held an open meeting Thursday the 10th at the American House with President Campbell in the chair.

Boston Branch will miss one of the best workers it has ever had in the transfer of Eric Rylander of Boston Branch to Chicago Branch. We wish him the best of luck in his new field.

The regular order of business was dispensed with as we had as the speaker of the evening, William J. Schneider, who is traveling around the country at the suggestion of T. F. Slattery, chairman of the Bureau of Education, taking as his subject "The Brass Plating of High Zinc Base Metals and the Diffusion of the Same." He spoke on the plating of die casting in brass and stated that he had done it and showed samples of work that he had done in 1925 and they were almost as good now as they were when first plated. He claimed that the brass sort of combined with the zinc but whether the brass adhered to the zinc or the zinc to the brass he could not tell but whichever way it is, he is satisfied that brass plating is the only plate or finish before nickel plating.

After his talk he answered all questions and a vote of thanks was given for his very interesting talk.

The meeting adjourned at 10:45 P.M. A. W. GARRETT.

BRIDGEPORT BRANCH

The regular monthly meeting of the Bridgeport Branch was held on Friday evening, January 4, in the Chamber of Commerce Rooms of the Stratfield Hotel. There were twenty members present. In the absence of President Al Rosenthal, Herman Brown presided.

Tom Chamberlain, Secretary of the Convention Committee reported that all committees were making progress and he urged that all members of all committees attend the meetings when called in order to carry out plans completely.

George Wagstaff took charge of the remainder of the meeting, and introduced Floyd Taylor as the guest speaker of the evening. His topic was

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WATERBURY, CONN.

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on Tank Rheostats, in which he explained the control from Anode to Cathode making a diagram on the blackboard, which he thoroughly explained.

Chairman Wagstaff announced that Mr. Hogaboom will be the speaker at the February meeting and all members of other branches are cordially invited to attend.

A vanity case was donated by John Barry as the door prize for the evening.

WM. H. FLAHERTY.

CHICAGO BRANCH

The regular monthly meeting of Chicago Branch was held January 12, at the Atlantic Hotel. President E. G. Stenberg presiding and all other Officers present.

J. Schulein was elected to active membership, E. Woodmansee transferred from the Detroit Branch to Chicago Branch and while we are sorry to see Detroit lose any of its members, Mr. Woodmansee received a hearty welcome by Chicago Branch.

C. S. Tompkins of the research committee read a letter from Mr. Phillips on the plans for the research work and urged all members to help in this most interesting and necessary work, by helping secure funds for carrying on same.

Mr. Emery spoke about the Chemistry Class, such as hours, length of time, tuition fee etc. The meeting was then turned over to O. E. Servis, our Librarian, who found the following questions in the question box:

No. 1. *What causes rustlike deposits (etched into steel or cast iron) in an electric cleaning tank, that is insulated from the floor with 2 x 4 with rubber between at both ends, and steam pipes before and after entering tank have steam hose insulation. Conditions do not allow using a wider tank with steel anodes. If cause is known how can same be corrected?*

Answer. Many suggestions offered such as cleaner is too weak or work run too long with reverse current also too much chlorides have gotten into the cleaner due to poor rinsing.

No. 2. *What is the best method to throw down silver in an old solution, also to recover silver from the solution?*

Answer. Throw down silver with very thin zinc sheets then zinc can be dissolved with Muriatic acid.

No. 3. *Want a good brightener for a bronze solution that will not throw off the color of the deposit.*

Answer. Rochelle Salts used in a bronze solution helps keep the anodes clean also helps some in keeping smut off of the work and makes it easier to control the cyanide.

No. 4. *What is the best procedure as to cleaning acid dip and nickle solution to nickel plate high carbon steel parts that have to be chrome plated?*

Answer. ½ gal. sulphuric acid, 5 gal. water, ½ lb. zinc sulphate, using a double nickel salt solution.

The Chicago Branch held their 23rd Annual Banquet Jan. 19, 1935, at the LaSalle Hotel.

The Educational Meeting started promptly at 2:30 P. M. E. G. Stenberg, President of the Branch, welcomed the members and guests with a few well chosen words, and introduced the Chairman of the meeting, Past President, O. E. Servis, who immediately went to work. The meeting finished at 4:45 P.M.

The Banquet started at 7 P. M. with 407 members and guests assembled at one of the largest and brightest banquets we have held in several years.

The dancing was excellent, and the music of Herbie Mintz's orchestra very fine. The floor show was nicely arranged.

Mr. Servis was in charge of the Educational Program and J. W. Hanlon, and C. S. Tompkins in charge of ticket distribution and music. Mr. Gilbertson was in charge of hotel arrangements, Messrs. F. Hanlon, H. Faint J. Hoefer, C. Stiers, C. Clindinin, E. Stenberg, who aided in placing of guests are all to be congratulated for bringing together for the Chicago Branch a very fine annual event.

The Branch Officers and General Committee, wish to thank the many friends and Supply Companies, who aided in making this a delightful event.

The Milwaukee Branch was in evidence by the gang they had present.

The Detroit Branch had several there, also several present from St. Louis Branch, and Minneapolis was well represented.

Among those we know we saw: W.H. Phillips, Detroit, C. Yearger, Matawan, N.J., G. B. Hogaboom, Matawan, N. J., G. Soderberg, Detroit, J. B. Davies, St. Louis, M. Froist, Minneapolis, C. Crompton, B. Oneil, E. Mercil, H. Schuessler, Mr. Leather —(Lea Greaseless Himself).

The following companies all had large parties of three or four tables each. Allied Industrial Products, Belke Co., Crown Rheostat & Supply Co., Ault & Wiborg, Dupont Co., R & H division, J. B. Ford Co., Hanson Van Winkle Munning Co., International Chemical Co., L'Hommedieu Co., Maas & Waldstein Co., Trojan Products., Udylite Process Co., C. Kocour Co., G. Westerberg, and Matchless Metal Polish Co., and there was much gayety at each spot.

It being Mr. R. J. Hazucha's birthday, Rudy appropriately sang a song for the gathering, and the boys all wish you many more happy birthdays Rudy.

Al. Slater also favored us with a song.

J. W. HANLON.

DETROIT BRANCH

A regular meeting of the Detroit Branch was held on Friday evening, January 4th, at 8:00 P. M., at the Statler Hotel, President J. H. Hansjosten presided, a good attendance being present. Minutes of previous meeting were read and approved.

Two applications for membership were reported favorably on by the Board of Managers, and the applicants were unanimously elected to active membership: — Robert Willard Jewell, 244 S. Marshall St., Pontiac, Mich., Howard W. Wright, 12742 Longview Ave., Detroit, Mich.

There were no new applications to present at this meeting.

Committee on Programs and Education reported that on February 21st we would hold a Joint Meeting in the Woman's Club with American Chemical and American Electro-Chemical Societies. The meeting will be very interesting as Dr. Fink of New York University will be the speaker of the evening. The expense of the meeting will be paid by these Societies acording to registrations. The meeting will be at 8:00 P. M. Dinner will be served at 7:00 P. M., the price of the dinner will be $.75 to be paid for by the individual. One can attend the meeting without taking the dinner.

Mr. Chusten and Mr. Littleton of the Wilbur Wright High School were present and gave us an idea of what they are doing for the Chemical instructions of platers and apprentice platers and invited all who wished to enroll for this semester which has already started. Our Educational Committee will look into this and report later.

Mr. McGuier of the Oakley Chemical Co. of New York City, read a paper on Cleaning of Metals. This paper was

very well read and instructive as well as interesting. Mr. McGuier was kept pretty busy for a while answering questions. Thepaper will be published in the REVIEW later.

The Question Box had only two questions: *No. 1. Some lime composition penetrated into the nickel plated surface and is very difficult to remove before chrome plating. How would you remedy the condition?*

Answer. Get some lime composition that will not give you this condition. Also have your nickel deposit more ductile so that the nickel buffer does not have to ride the wheels so hard as to burn the composition, which then forms an oxide which is almost impossible to remove by ordinary cleaning before chrome plating. Or educate your buffers in what real nickel buffers should know. It seems that nickel buffing is not taught. It seems that this part of the electroplating department is being somewhat neglected in this way. Especially is this true in automatic nickel buffing, there is generally too much pressure on the articles and this caused too much heat which caused the composition to oxidize on the work more than it, being imbedded into the nickel deposit.

Question No. 2: Which is the better current to use in electric cleaning and why?

This is a large question and very difficult to answer. Therefore it was suggested that it be left open for general debate. (Platers and cleaning experts please note).

It was however answered in a way. That it all depends upon the kind of metal which is to be cleaned. Die castings or any non-ferrous metals should be cleaned in an electric cleaner with direct current or the work to be cleaned should be the cathode.

Steel, iron or any ferrous metal can be cleaned with either direct or inverse current.

This is a matter upon which much can be said and upon which expert platers differ. Some use one and some another, and some use both direct and inverse.

T. C. EICHSTAEDT.

ROCHESTER BRANCH

On Friday night Jan. 25 the Rochester Branch held its regular monthly meeting at the Seneca Hotel. Meeting was called to order by President Kohlmeier and the minutes of previous meeting were read and accepted. After the reading of the communications a motion was made to invite Mr. Wm. Schneider, better known as "Cyanide Bill" to read a paper on "Brass Plating of High Zinc Base Metals" at our March meeting and making this an open meeting. Passed. Under new business a motion was entertained to hold our annual bowling party and it was decided to hold it sometime in April. The following committee was appointed: S. P. Gartland, Chairman, Chas. Hehr, A. S. "Bert" Groh.

We had as a guest Mr. Ray Bergholdt of the Scobell Chemical Co., who favored us with a few remarks.

At a special meeting held on Tuesday evening Jan. 15th the members of this Branch were privileged to hear Mr. Geo. B. Hogaboom in an interesting and timely talk entitled "What is Under the Plate?" This talk was illustrated with slides and held the attention and interest of the large group who attended right to the end. It is only regrettable that there was not a larger number of production managers in attendance for they certainly would have realized after this talk all the different conditions and griefs that a foreman plater has to contend with in order to supply the finish required.

It was one of the most enlightening talks which we have had the privilege to hear. And to Mr. Geo. Hogaboom, the Rochester Branch unanimously extends its thanks.

JUDSON R. ELSTER.

WATERBURY BRANCH

The January meeting of Waterbury Branch was presided over by President Tennant Elwin. The members turned out pretty strong for the meeting which was held in Engineers' Hall. Reports from committees having in charge the remaining meetings of the year were received and each would indicate a large gathering for every meeting.

The February meeting which takes place Friday, February 8th, will be featured by Robert Leather, who will give a talk accompanied by pictures of his recent trip abroad.

Invitations to attend the banquets of Baltimore-Washington Branch and the New York local were received and read.

Communications from the Waterbury Sponsoring Committee in re unemployment and social insurance, was referred to the Board of Managers. The semi-annual report of Supreme Secretary-treasurer, E. Steen Thompson, was read and favorable comment ensued.

Committee on new members reported that application blanks had been sent to prospective candidates and favorable results were expected in the near future.

A short discussion on the research papers recently issued "Protective Value of Nickel and Chromium Plating on Steel" and "Accelerated Tests of Nickel and Chromium Plating on Steel" kept the members interested until adjournment.

W. F. GUILFOILE.

CHARLES R. SHERMAN

New Vice-President of Ault & Wiborg Corp.

Charles R. Sherman, who has recently been appointed Vice-President of the Ault & Wiborg Corporation, with headquarters at Cincinnati, brings with him a varied experience and fine record of accomplishment in the Paint, Varnish and Lacquer Industry.

After graduating from the University of Indiana in 1913, where he majored in economics and political economy, Mr. Sherman joined the Schofield, Pearson Company of Indianapolis in 1914, taking charge of their steel die and copper plate engraving departments. He soon resigned to become manager of the Stafford Engraving Company of Indianapolis, at that time the largest steel die, copper plate and photo engraving firm in the State.

Upon the entrance of the United States into the World War, Mr. Sherman left to enter the First Officers Training Camp, where he was commissioned. Before the end of the war he had received two promotions, and in February 1919 was discharged as captain and chief purchasing officer of the Quartermaster Depot at Jefferson, Indiana.

Immediately after his discharge from military service, Mr. Sherman accepted a position as Production Manager of the R. M. Hollingshead Company of Camden, New Jersey, manufacturers of paints, enamels, dressings, cements and polishes, where he soon became General Manager of Operations. Early in 1933, with the title of Vice-President and General Sales Manager, he resigned to join The International Printing Ink Corporation.

During Mr. Sherman's fourteen years spent in the East, he was very active in American Legion affairs, having been Commander of Post 38. He was also a Director of the Elizabeth Haddon Building and Loan Association; a

member of the Executive Council of the Boy Scouts; and at the time of leaving the East, was Vice-President of the Camden, New Jersey, Rotary Club.

For the past two years Mr. Sherman has been manager in charge of The International Printing Ink Corporation's operations in Chicago and has also acted as Assistant Western Manager.

Upon assuming his new duties at Cincinnati, Mr. Sherman will be in complete charge of all manufacturing operations and will assist in supervising and directing sales policies under the direction of Mr. Joseph R. Esposito, President of Ault & Wiborg, and his intimate friend for many years.

While the executive order announcing Mr. Sherman's appointment is dated January 2nd, it is understood that he will not officially report to take over his new duties until about January 20th. His genial personality and business ability have won him a host of friends throughout the country who will be pleased to learn of his advancement, and while his associates and friends in Chicago are sorry to see him leave, he carries with him their hearty wishes for his success.

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Membership Report

ELECTIONS

Harold E. Beshey, Coleman Lamp & Stove Co., Wichita, Kansas, Active, St. Louis Branch

Daniel McMullen, 3581 Durocher St., Montreal, Canada, Active Montreal Branch

Joseph Schulein, 832 S. Central Ave., Chicago, Ill., Active Chicago Branch

Floyd Julian Waugh, 14346 Ardmore Ave., Detroit, Mich., Active Detroit Branch

Howard Knight, 12742 Longview Ave., Detroit, Mich., Active Detroit Branch

R. W. Jewell, 244 S. Marshall St., Detroit, Mich., Active Detroit Branch

TRANSFERRED

Eric Rylander, 64 Woodstock Ave., Brighton, Mass., Associate Boston to Chicago Branch

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